The Shape and History of the Moon

- Presented to ***The Lunar Science Forum***

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- By Charles J. Byrne

Image Again

charles.byrne@verizon.net

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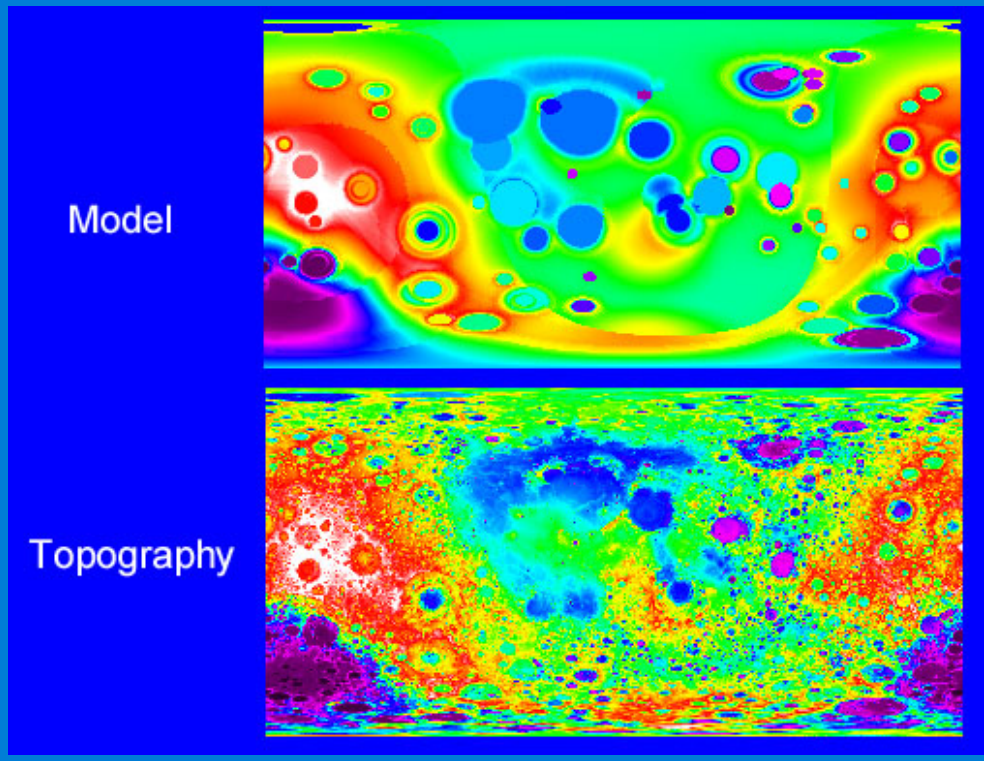

The Dichotic Moon

- The "Man in the Moon" (maria patterns) are mostly on the near side
- The near side is low, a bulge on the far side
- The crust is thin on the near side, thick on the far side
- Heavy element anomalies are mostly on the near side
- Moments of inertia are uneven
- Center of gravity is offset to the near side

Near Side of the Moon

Far Side of the Moon

Maps of the Current Moon

- Topography
  - Photography
  - Digital Elevation Map (DEM)
- Gravity
- Crustal thickness
- Mineral concentrations

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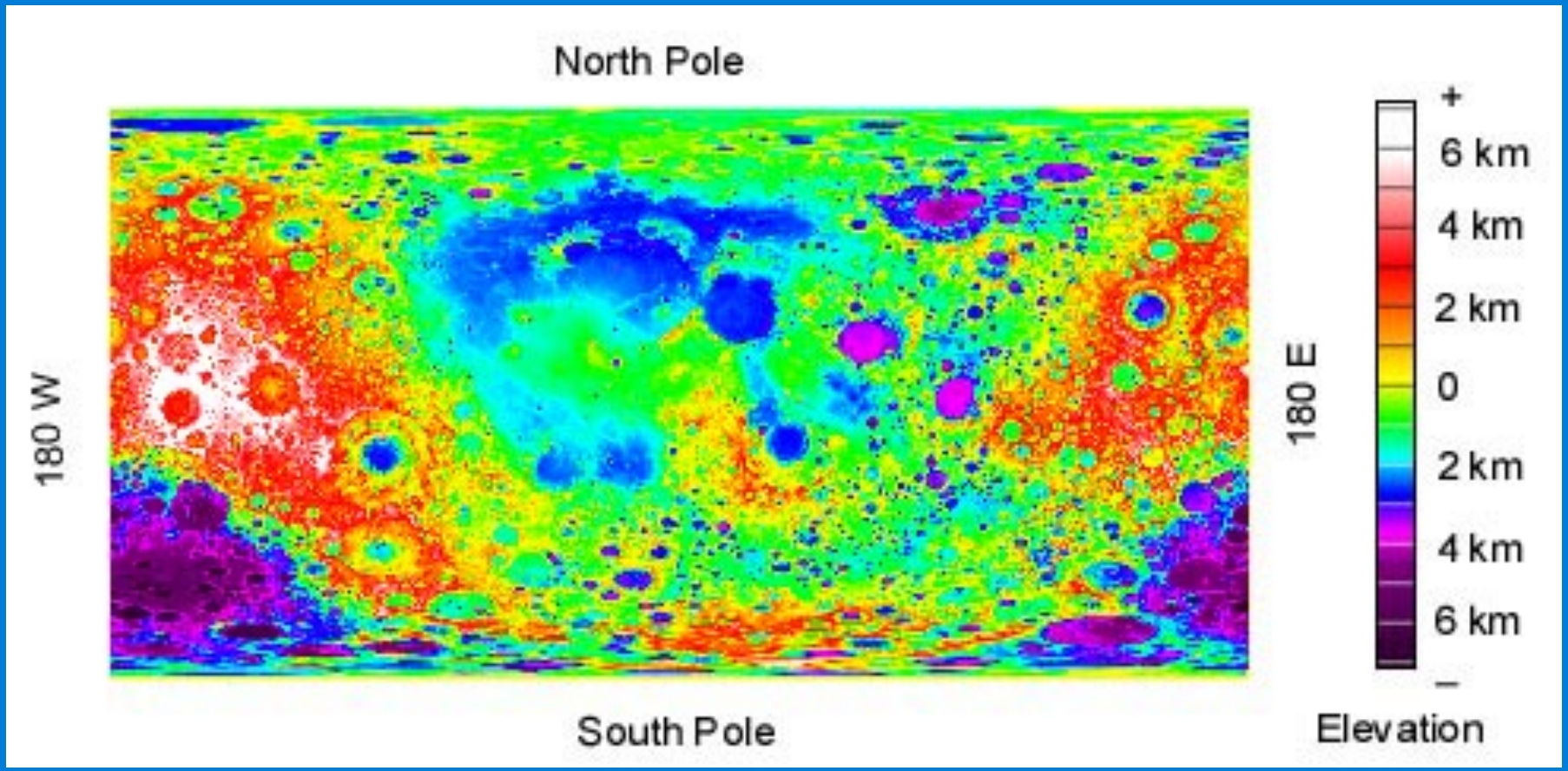
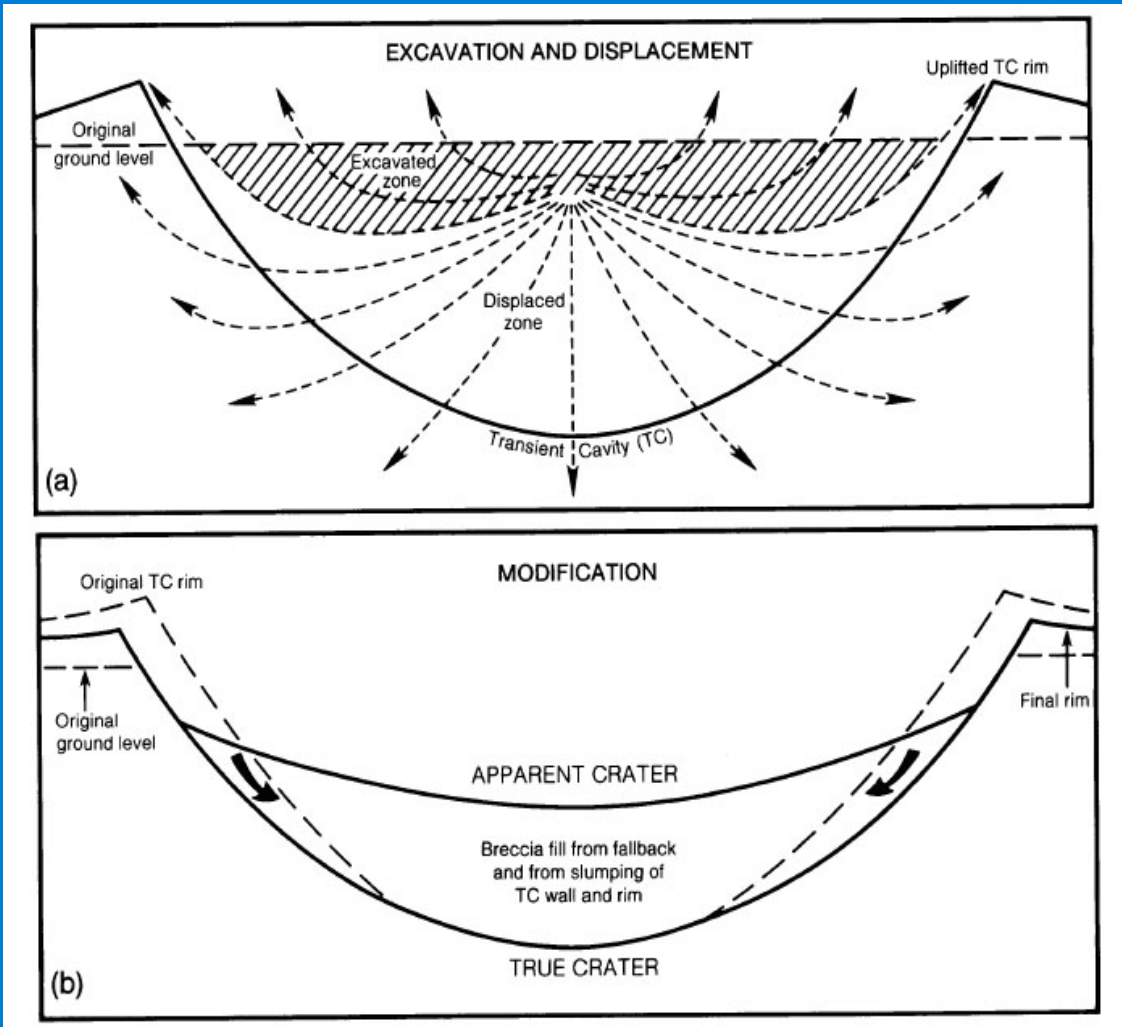
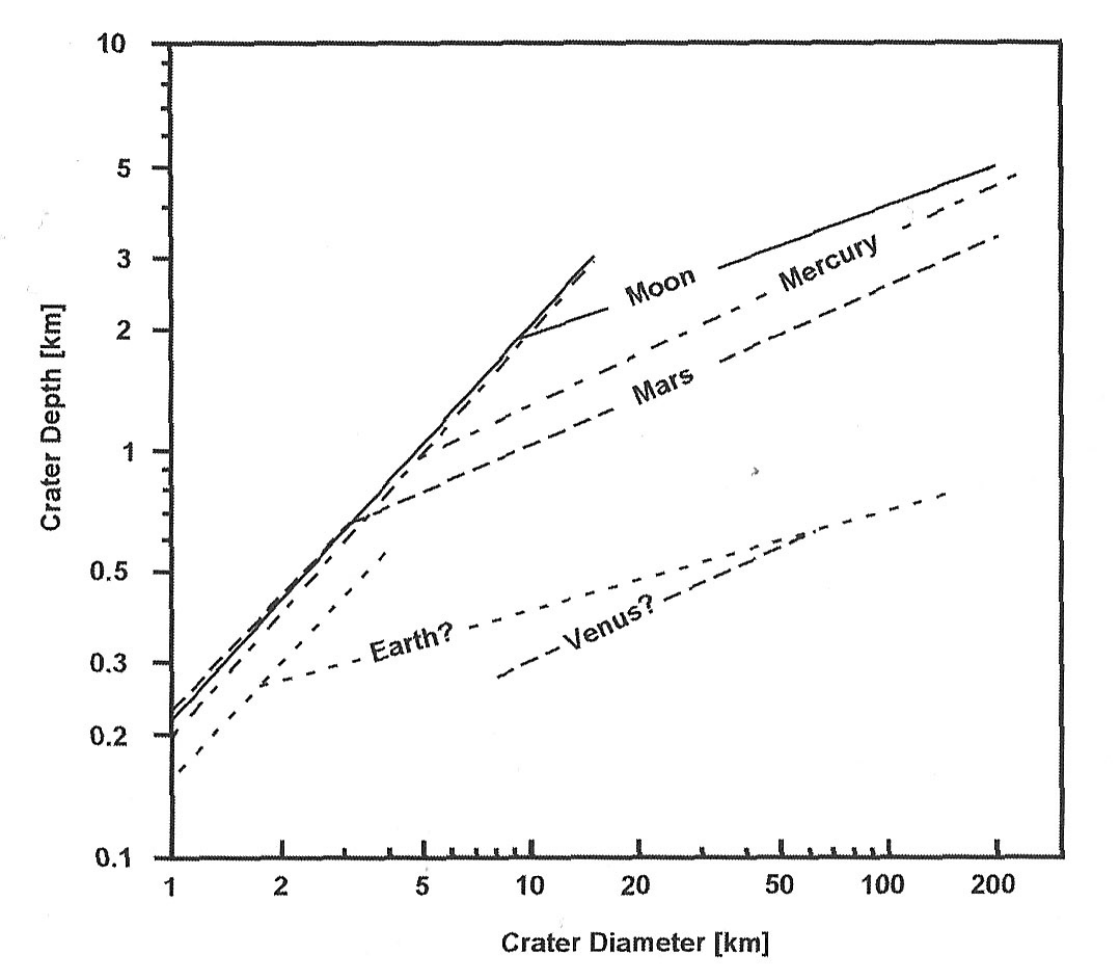
Digital Elevation Map (DEM)



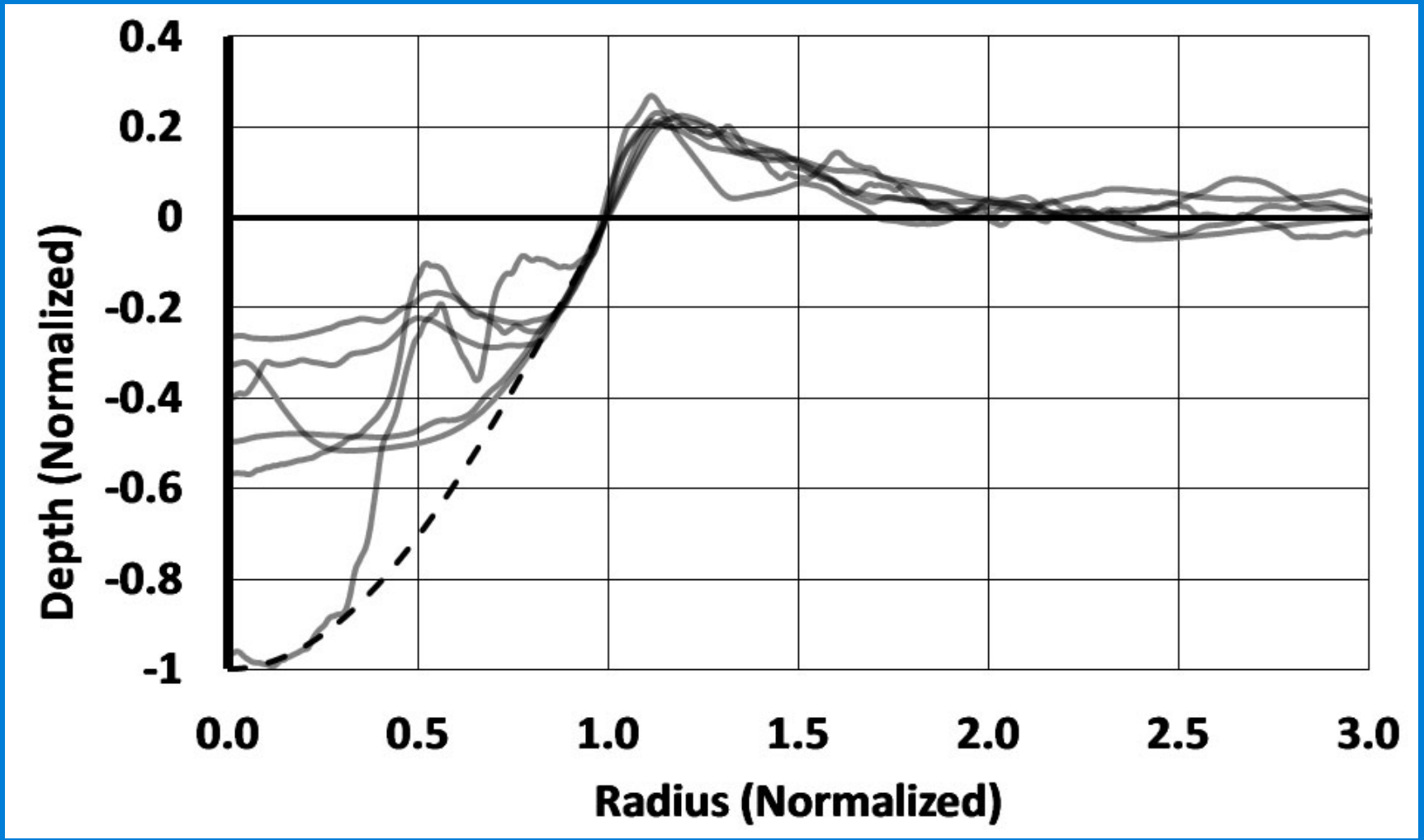
Impact Model: Maxwell-Z



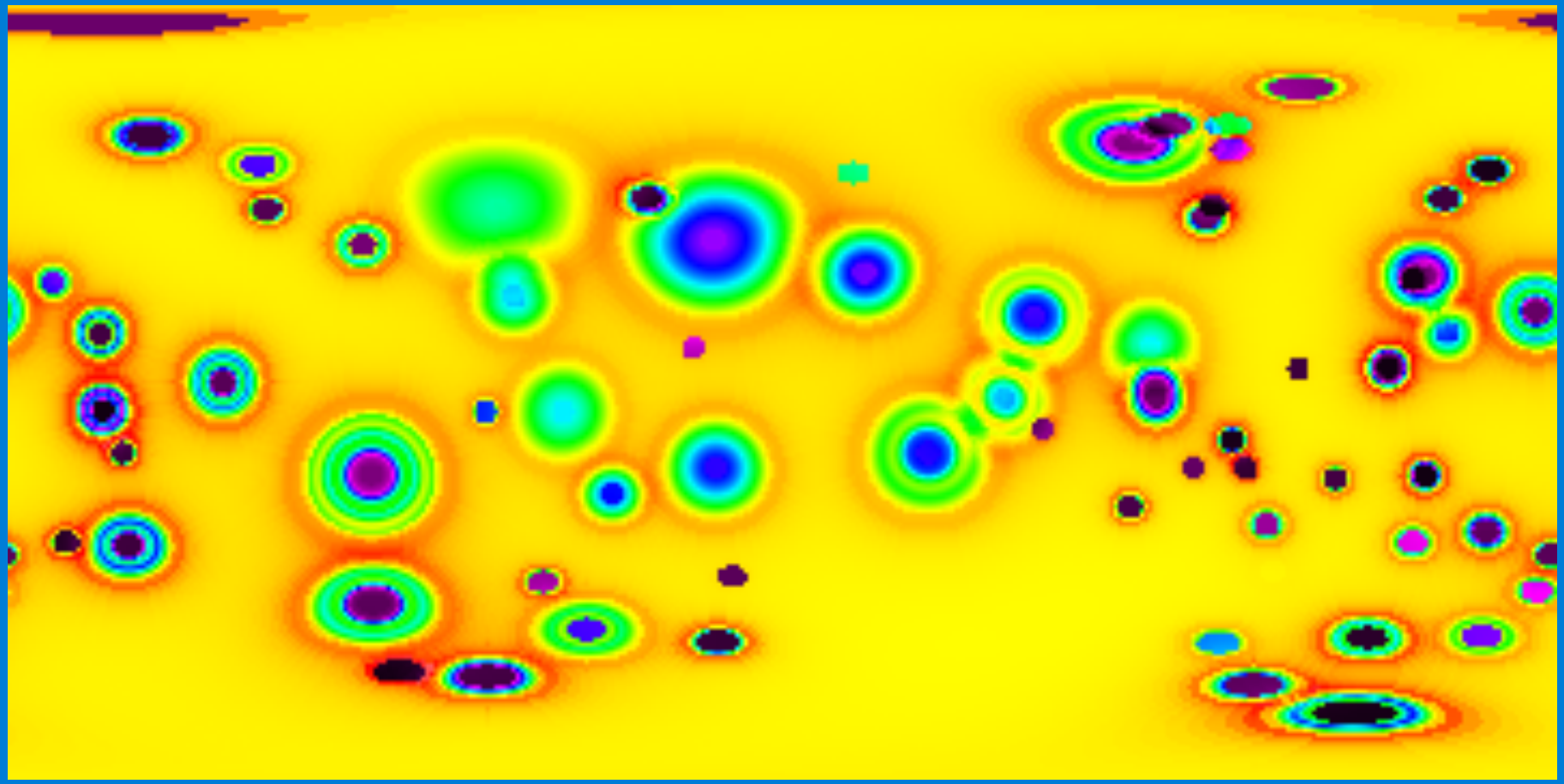
Crater Depth vs. Diameter



Scaling by Depth and Diameter



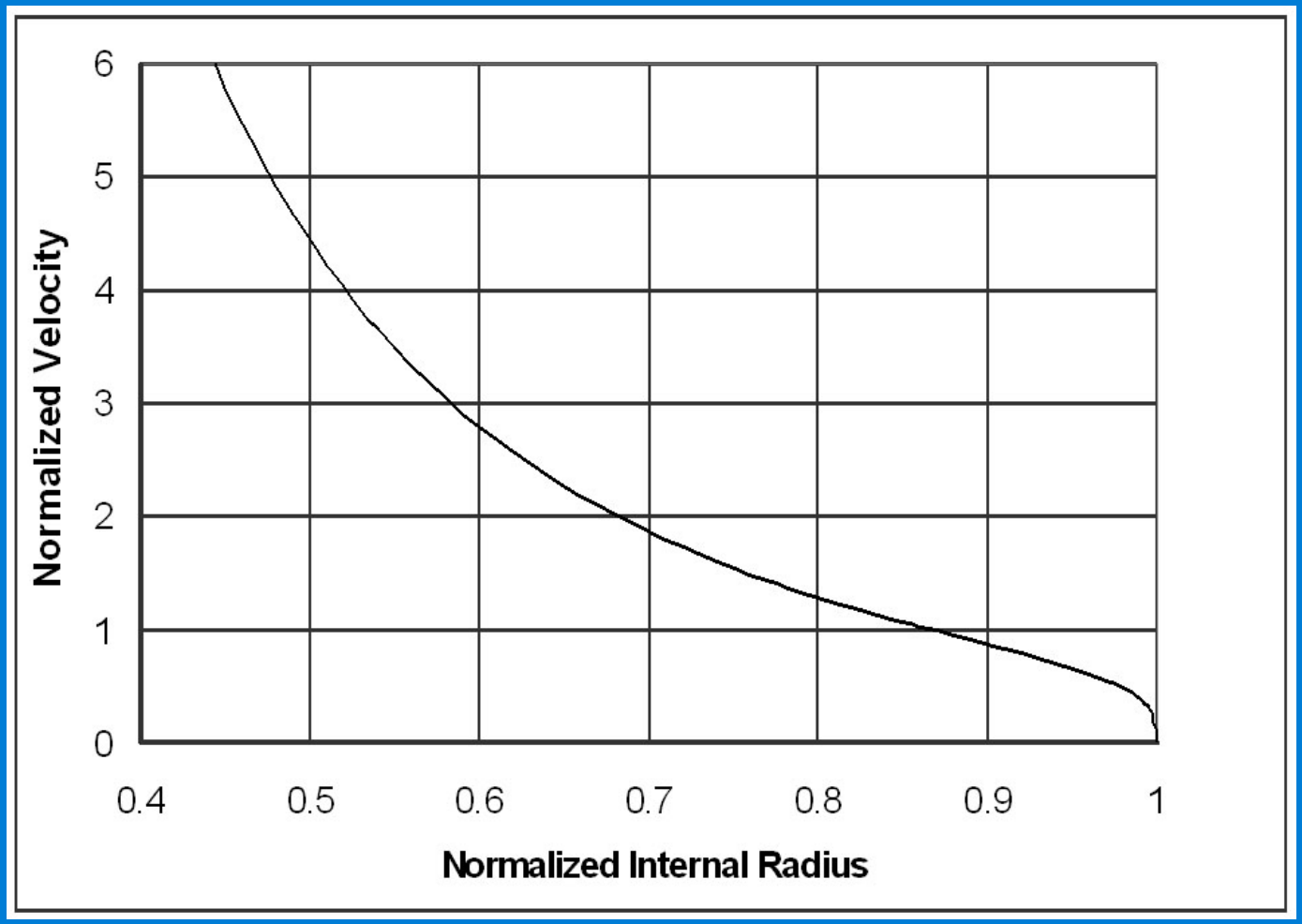
Models of Basins and Large Craters



The Big Guys: Megabasins

- A megabasin is a basin that contains other basins
- A model of a megabasin must consider the spherical nature of the Moon
- Ejecta is thrown into elliptical orbit: velocity as a function of radius is needed
- Near the antipode, ejecta is focused: the depth of the ejecta field increases

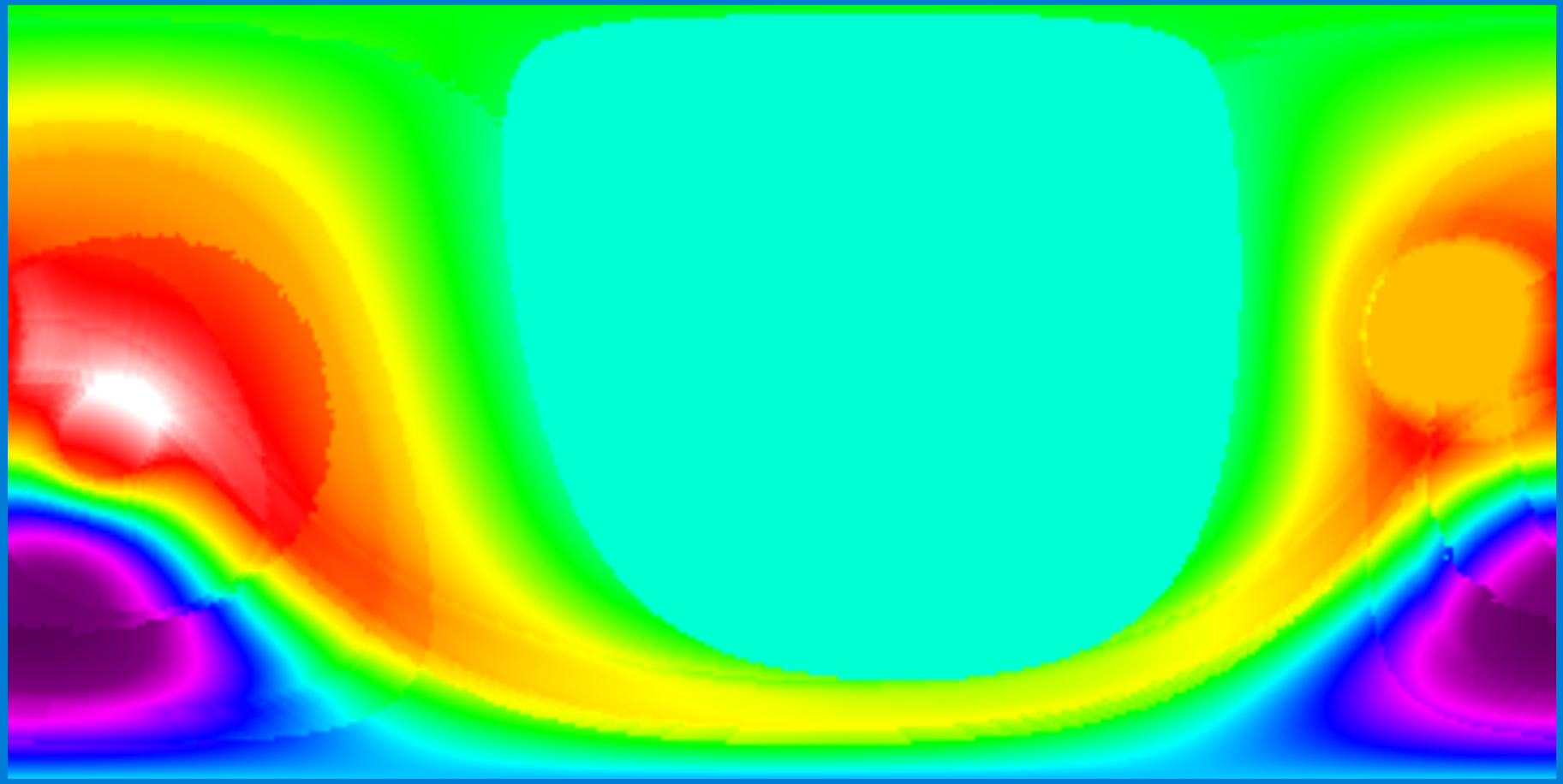
Scaled Velocity Profile



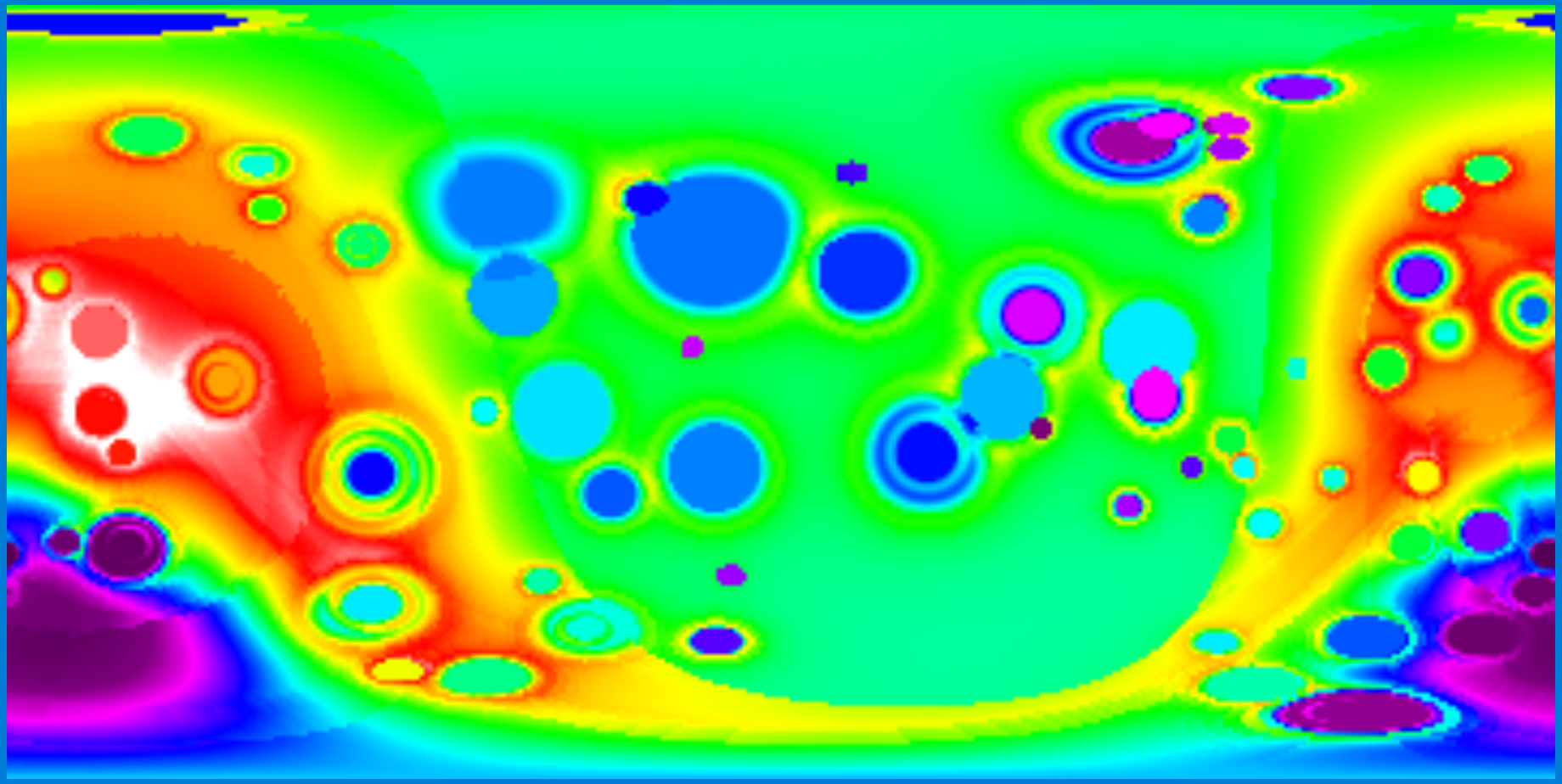
The Search for Megabasins

- Model parameters : center latitude and longitude, diameter, depth, and fill
- Two megabasins were modeled together: the South Pole-Aitken Basin (SPA) and a mystery basin
- Parameters were varied to best fit the Moon
- Both the Near Side Megabasin (NSM) and its ejecta field, the far side bulge, emerged.
- The St. John-Teselius Basin emerged from the residual DEM of SPA and NSM.

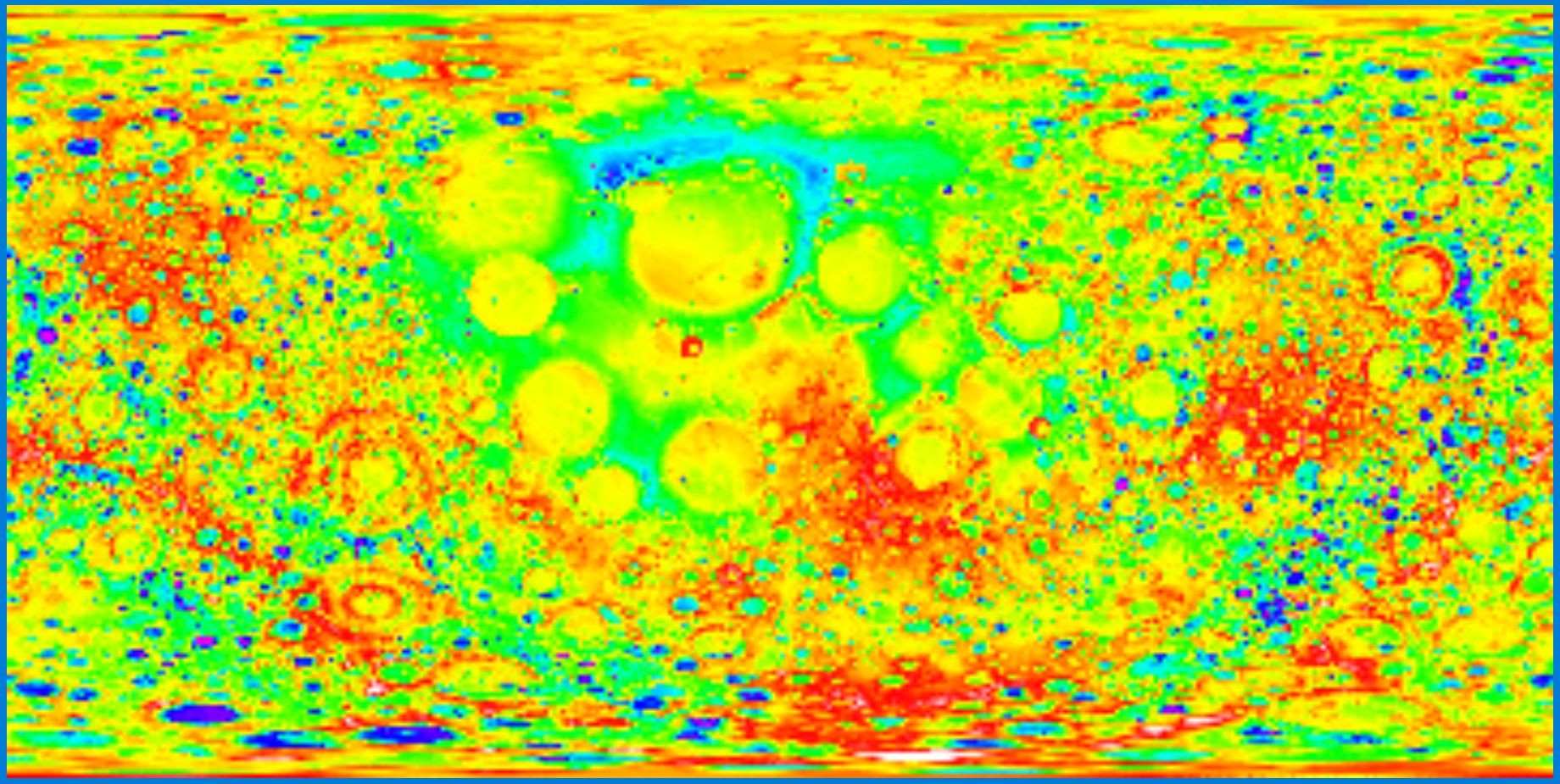
Three Megabasins



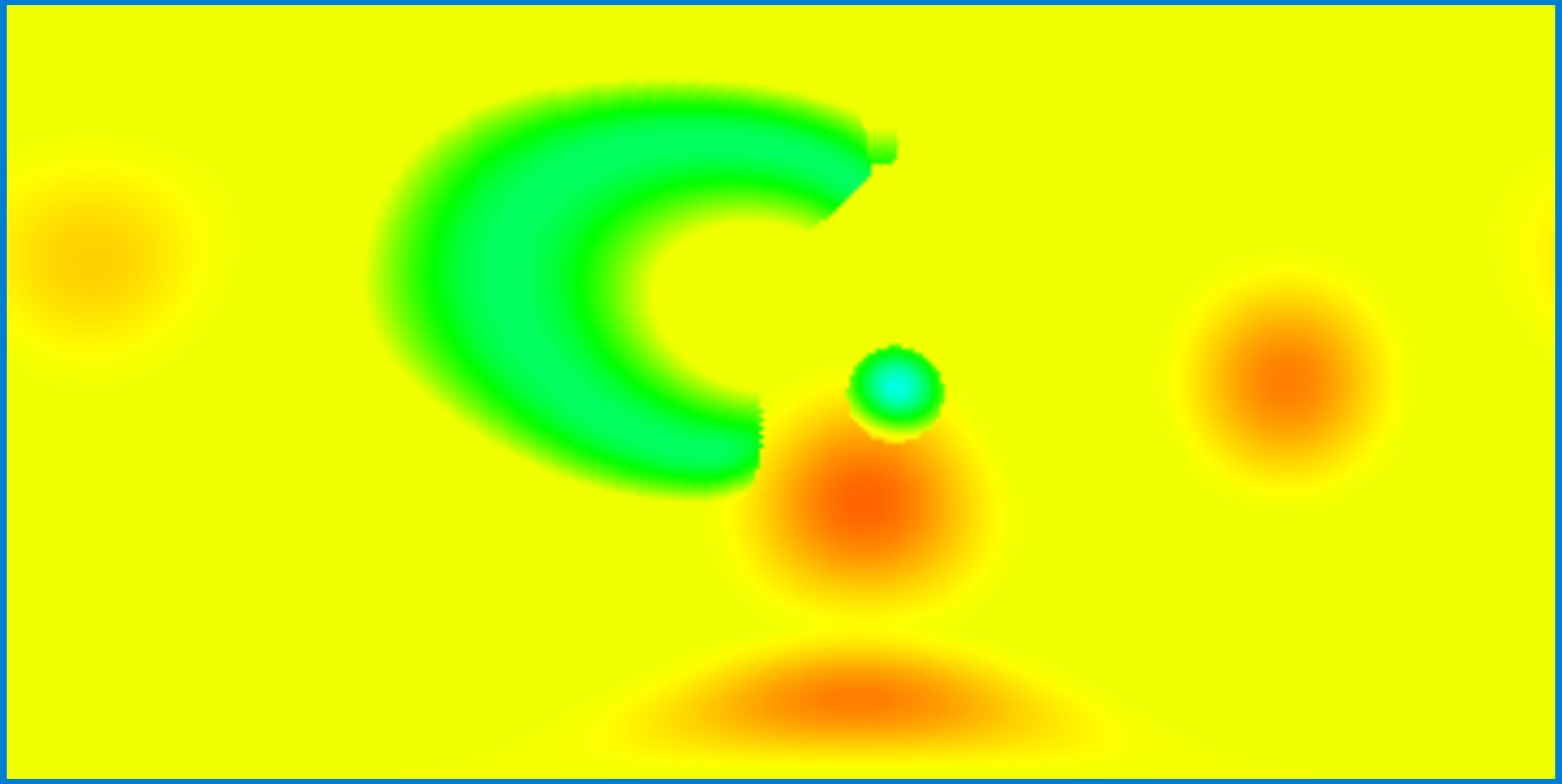
Megabasins, Impacts, and Maria



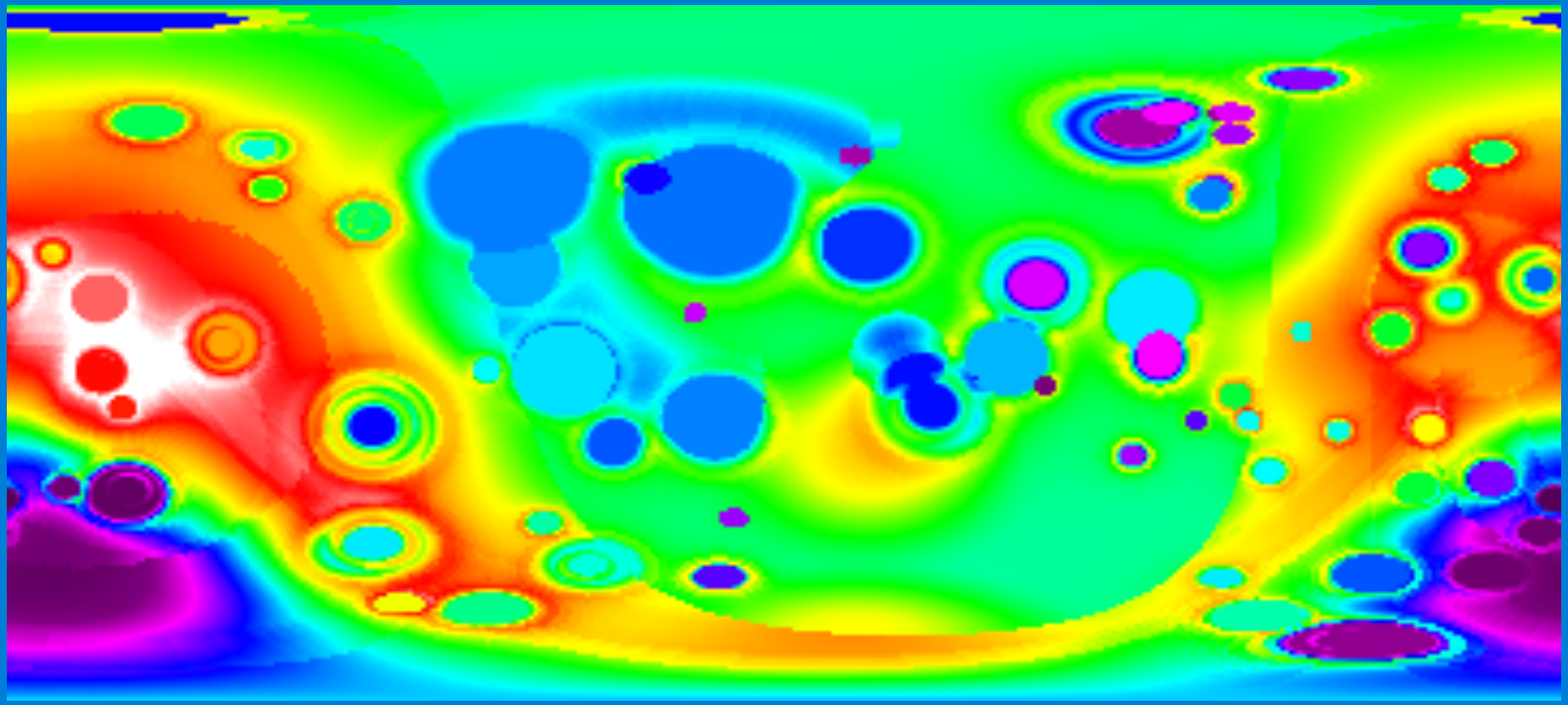
Interim Residual DEM



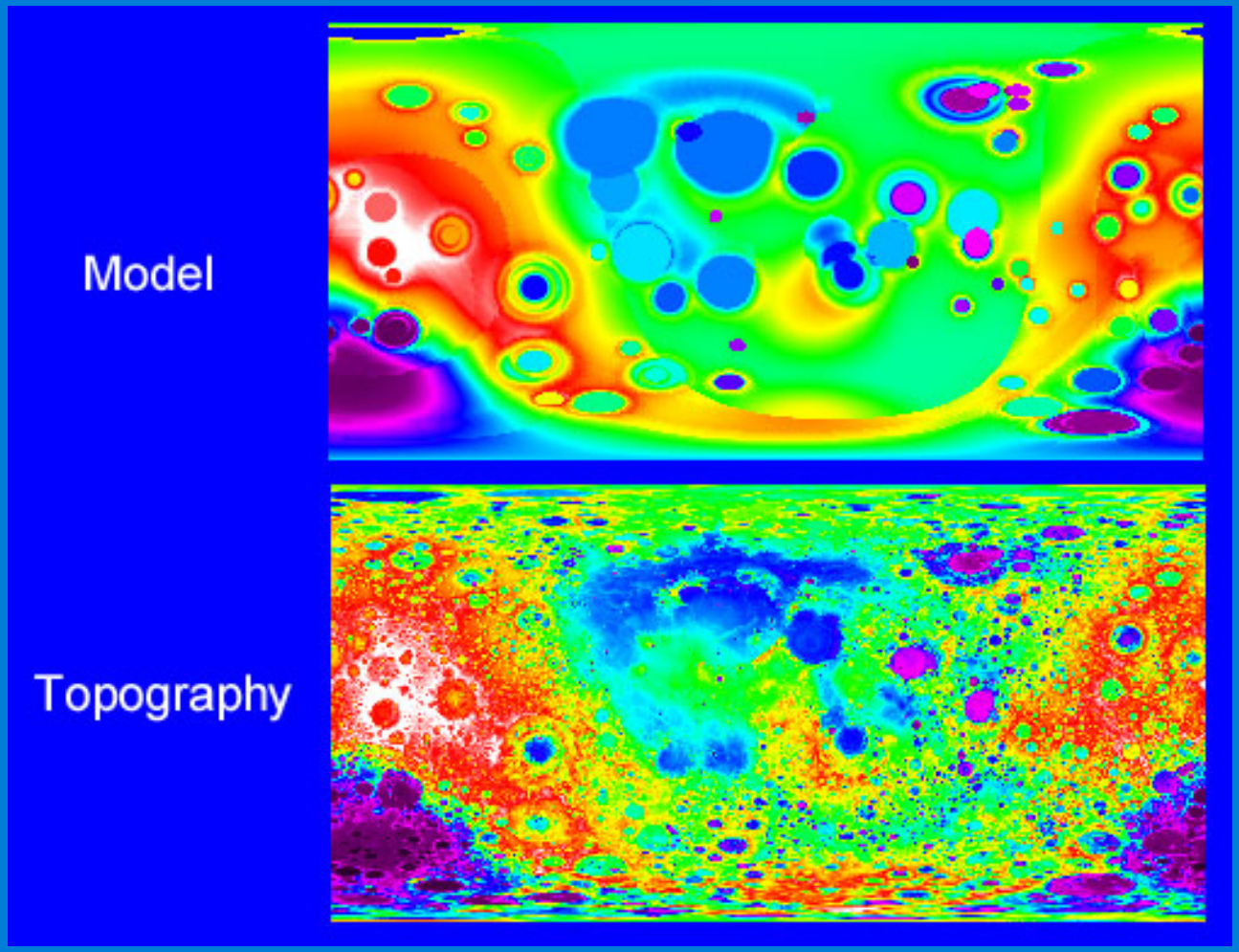
Mounds and Depressions



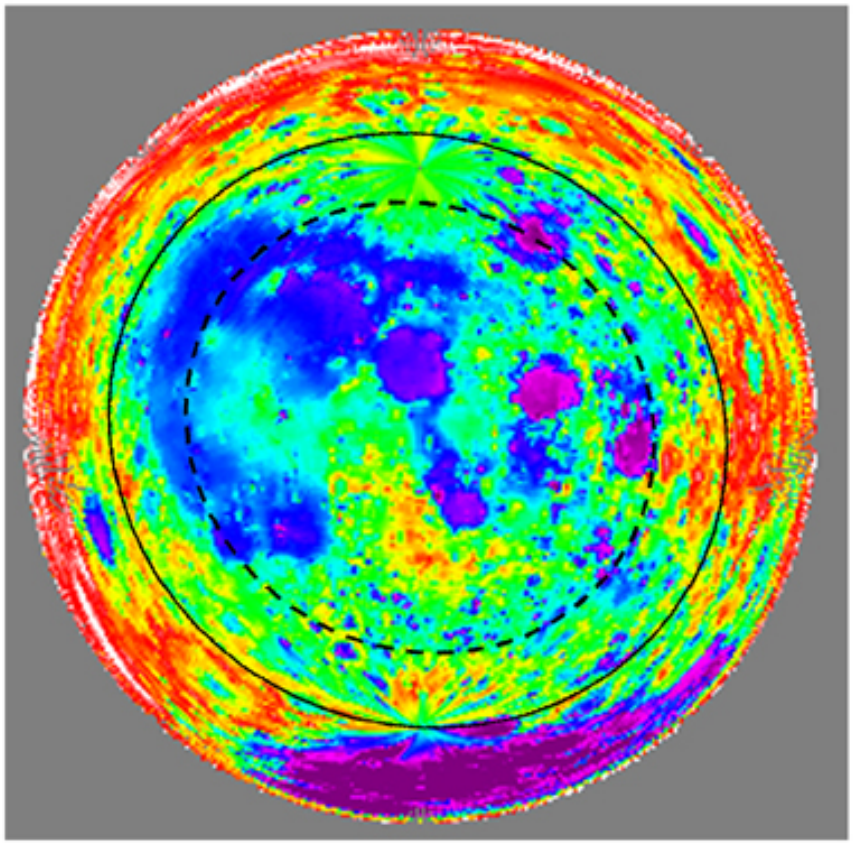
Comprehensive Model

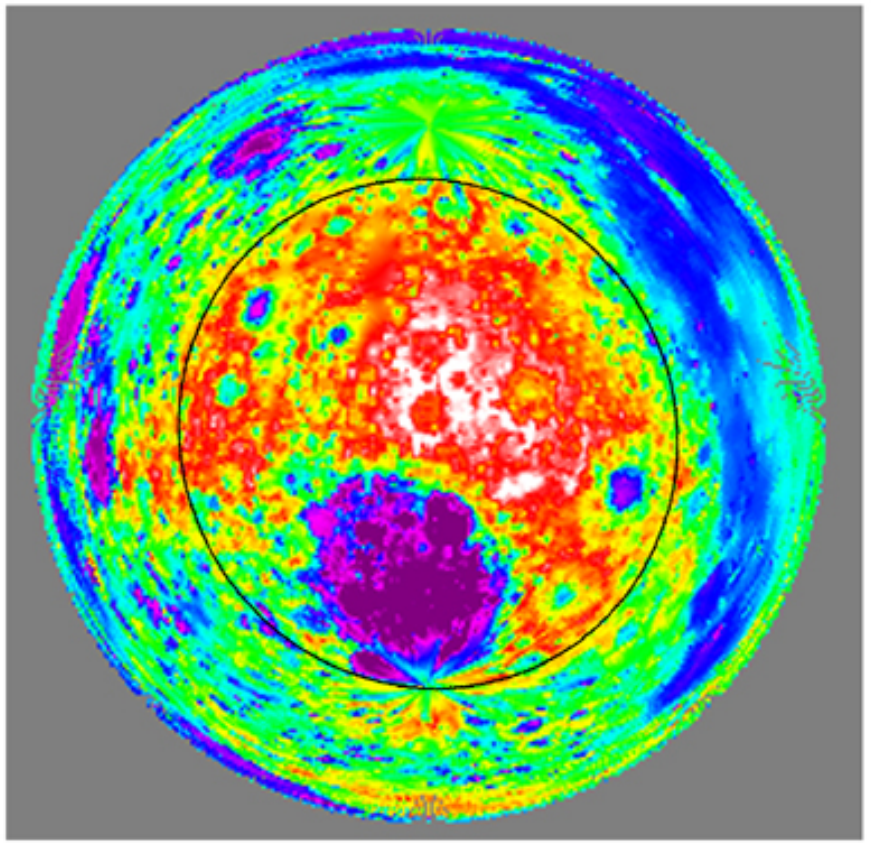


Model Compared to Topography

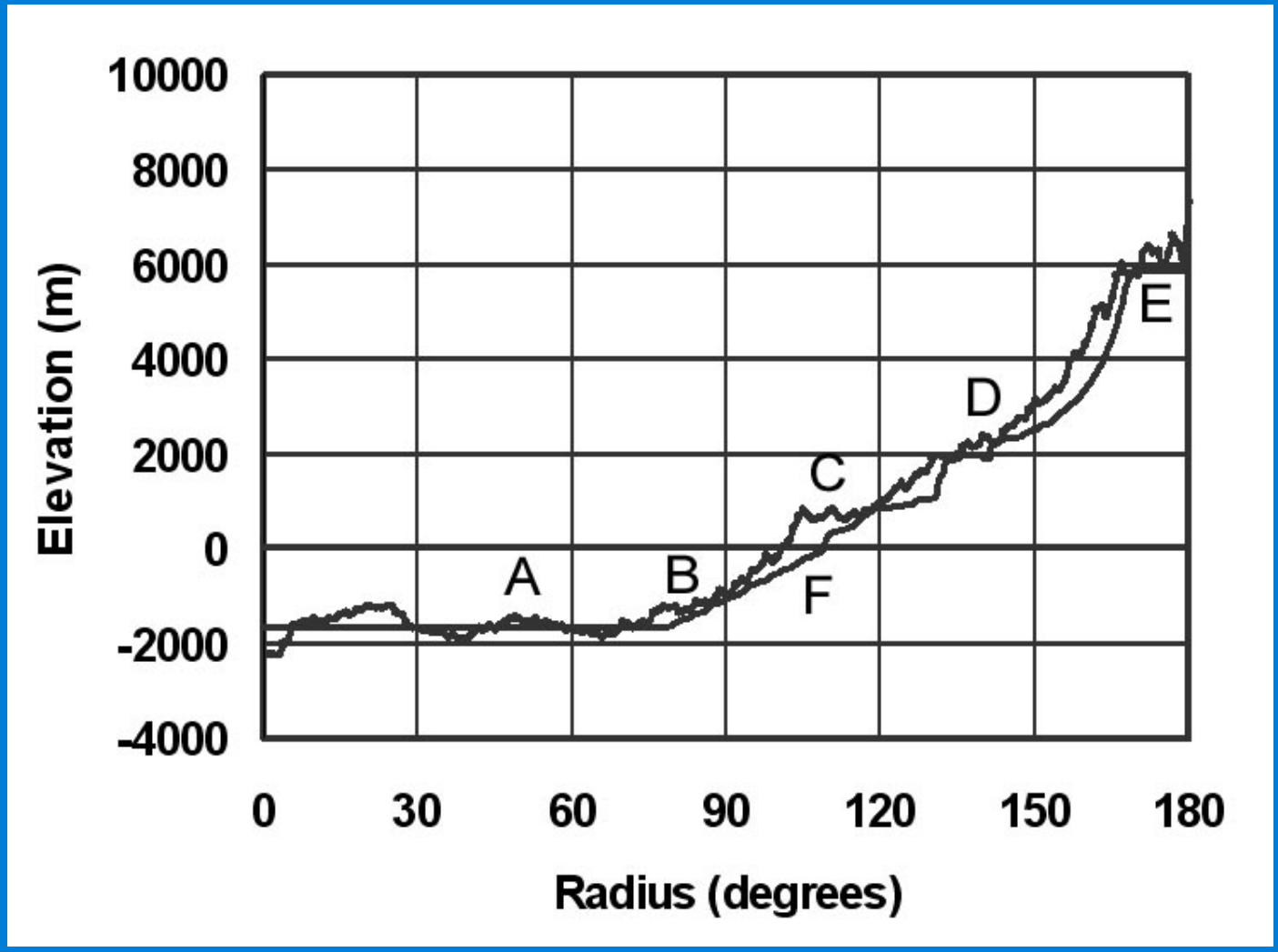


The NSM and its Antipode



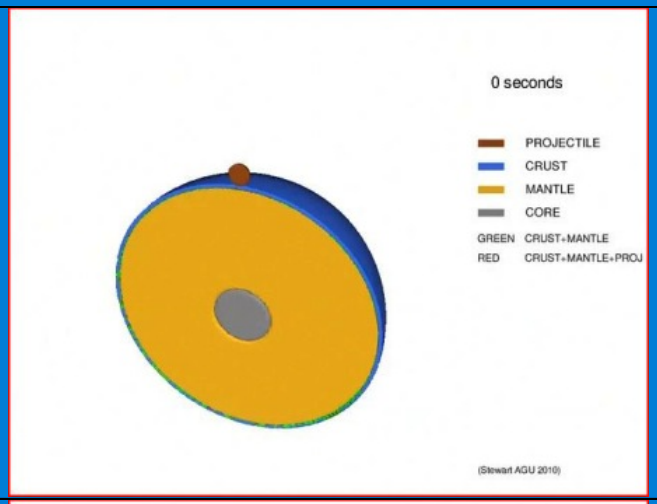


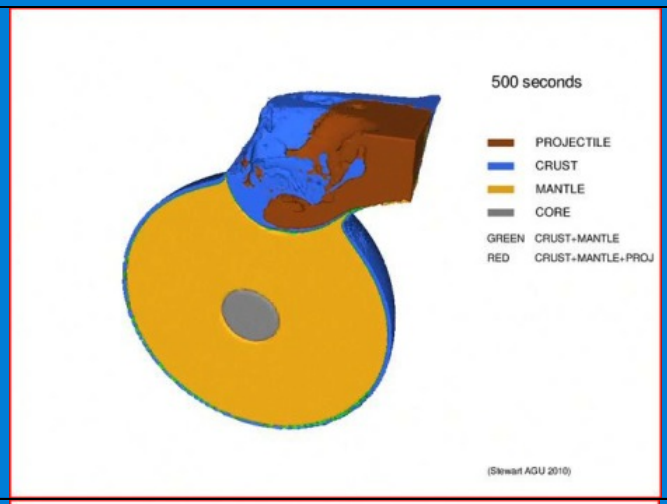
Radial Profile of the NSM



SPA Impact Simulation (Stewart)

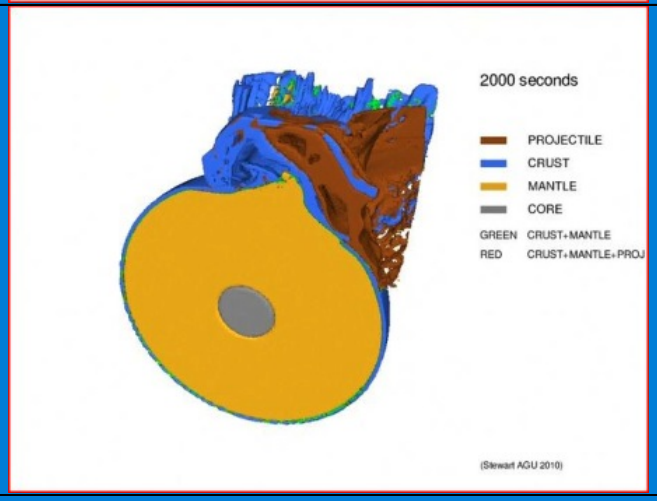
A
000

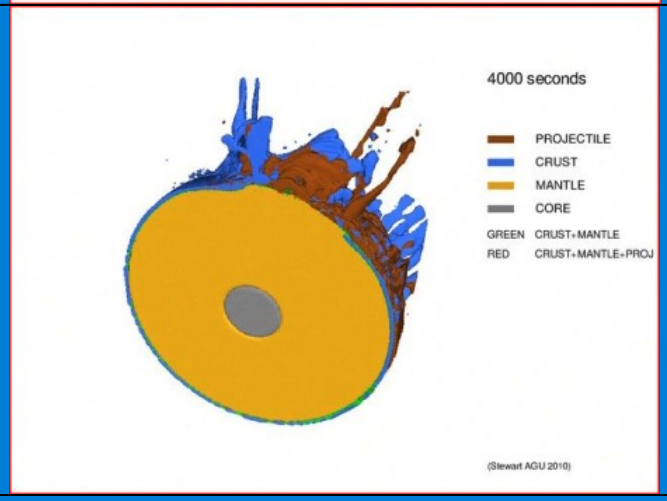




B
500

C
2000



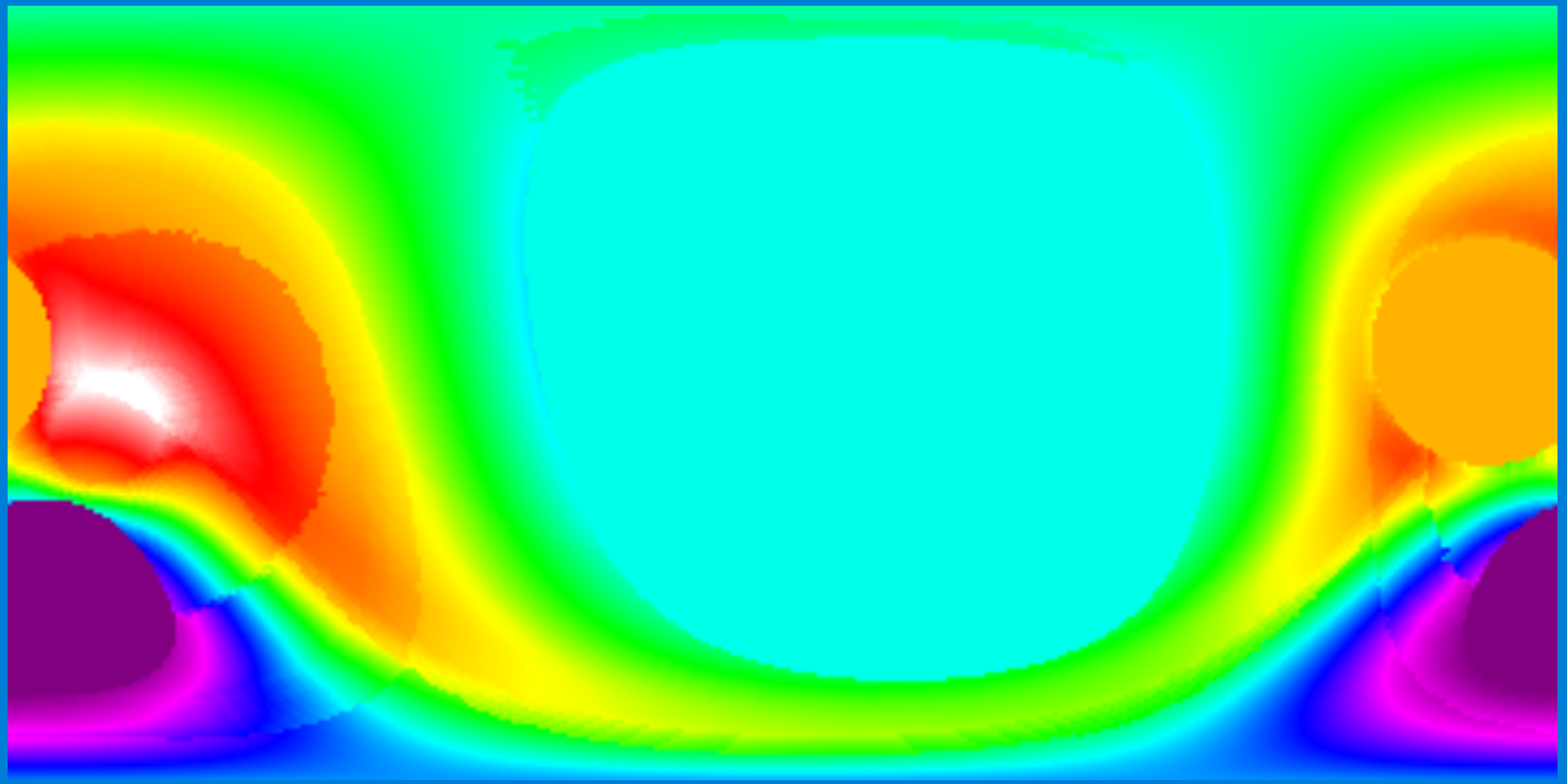


D
4000

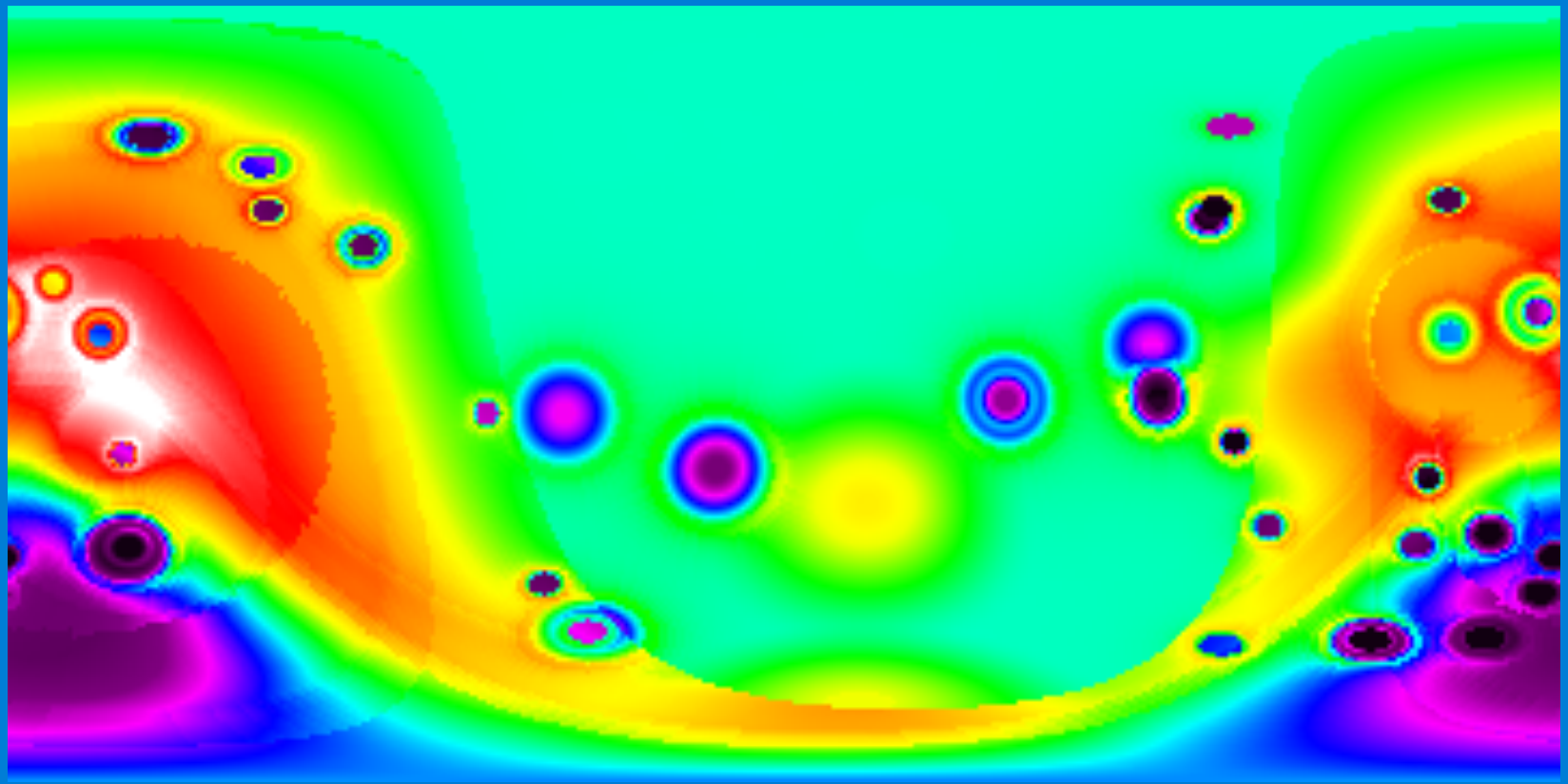
History of of the Moon

• Accretion	4.5 Ga
• Megabasins	4.34 - ?
• pre-Nectarian Period	4.34 - 4.0 Ga
• Nectarian Period	4.0 - 3.9 Ga
• Early Imbrian Period	3.9 - 3.8 Ga
• Later Imbrian Period	3.8 - 3.2 Ga
• Eratosthenian Period	3.2- 0.8 Ga
• Copernican Period	0.8 - 0 Ga

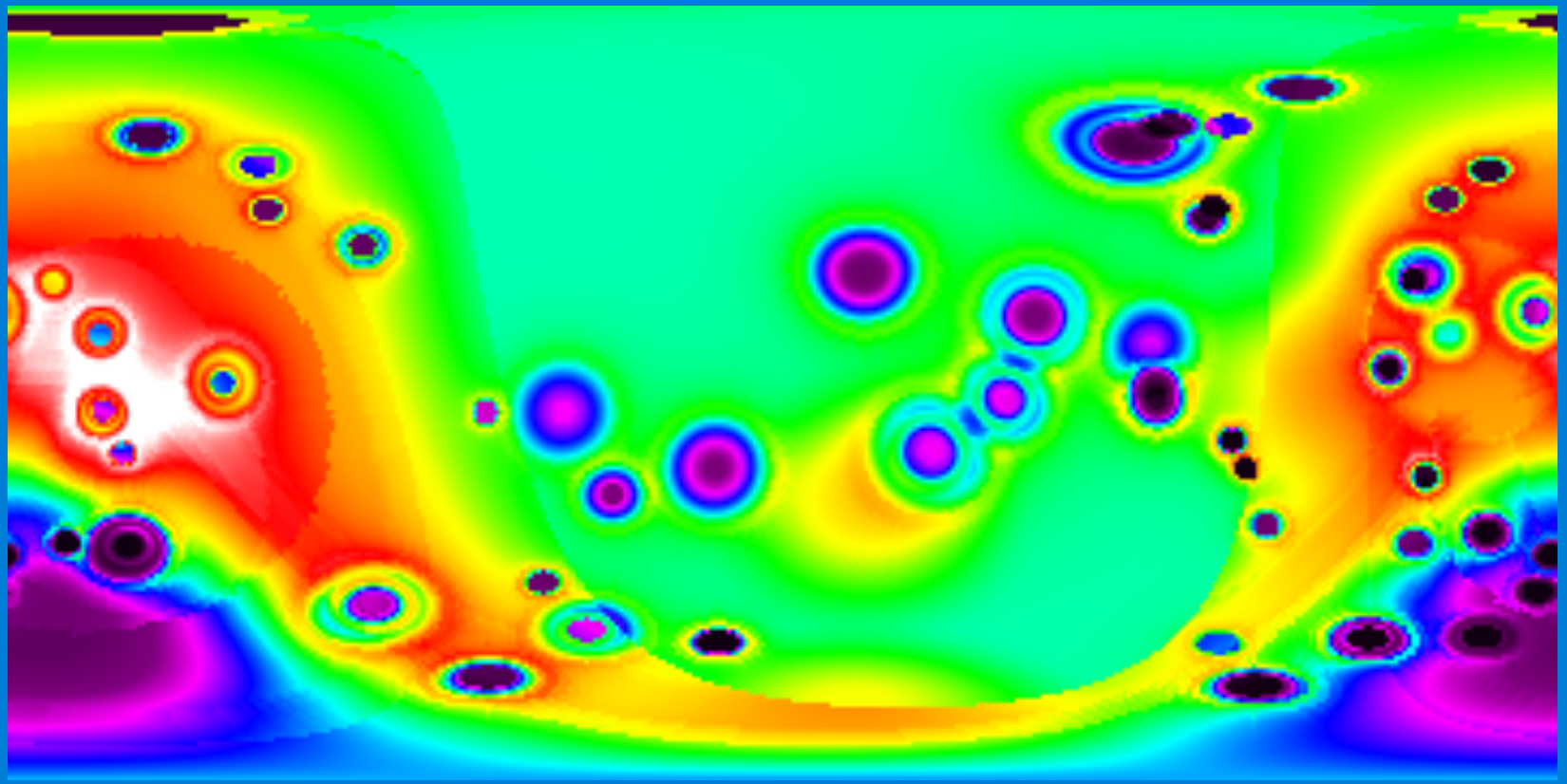
Megabasins (4.34 Ga - ?)



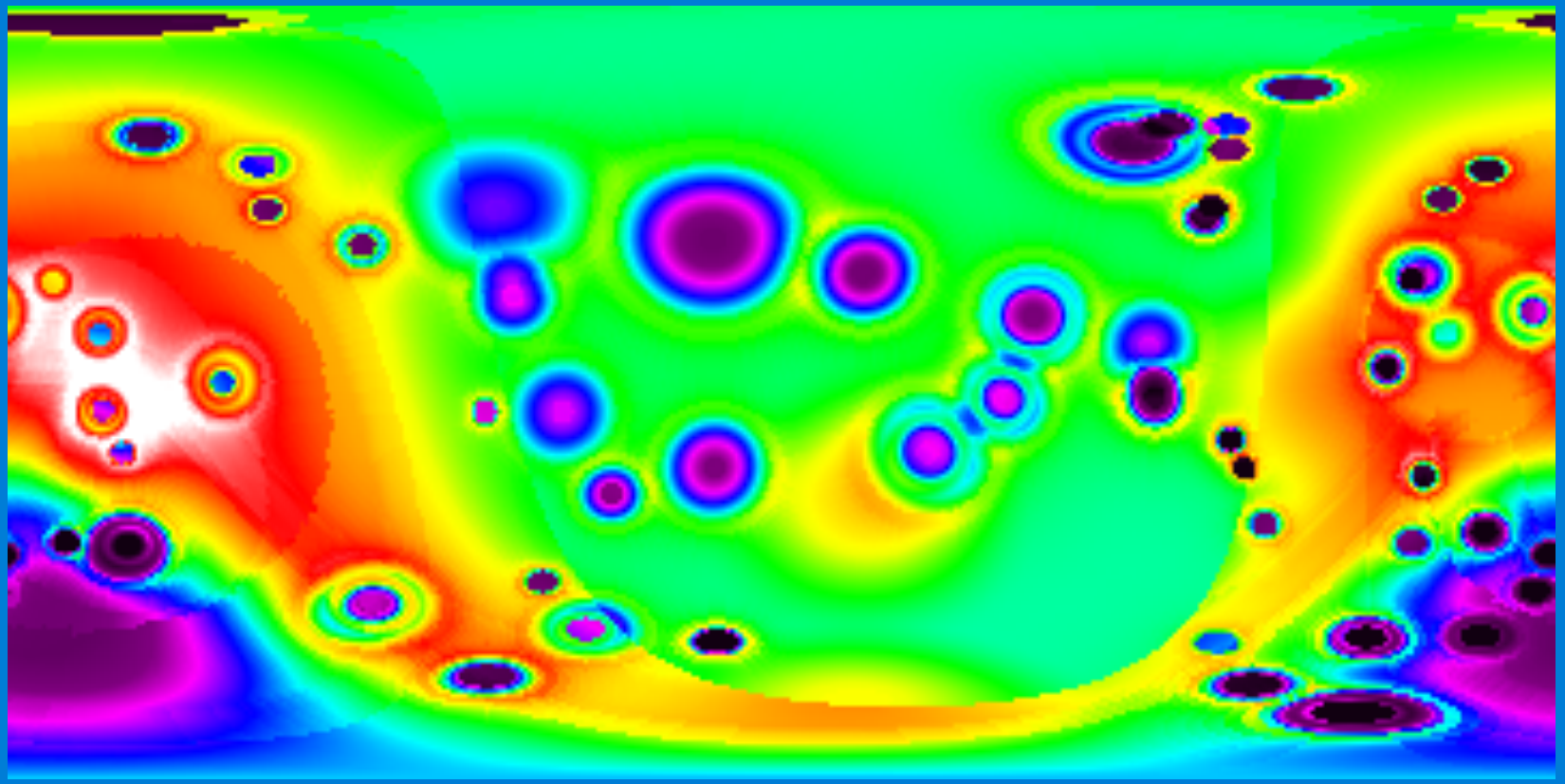
Pre-Nectarian (700 Ma)



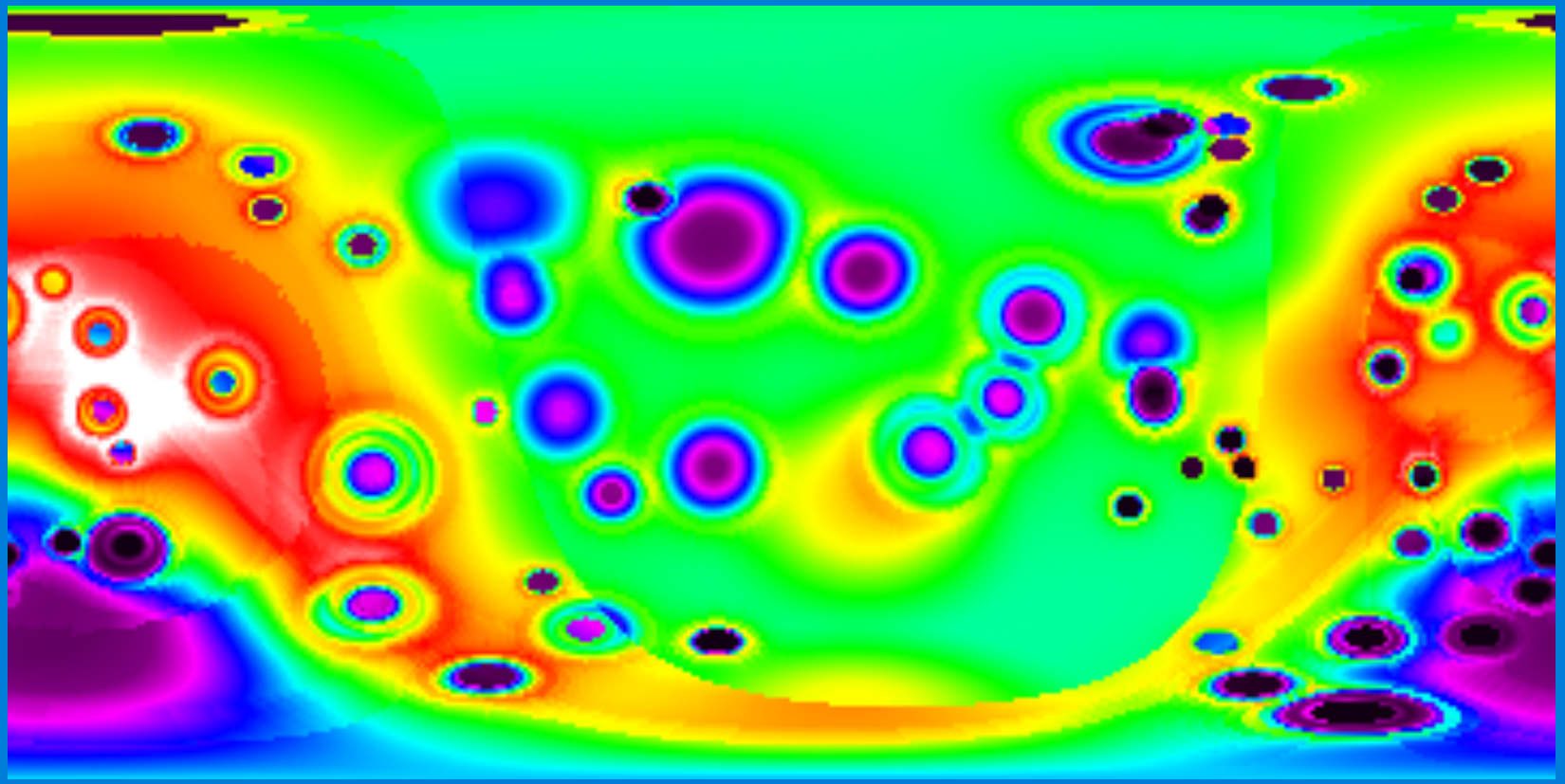
Nectarian (100 Ma)



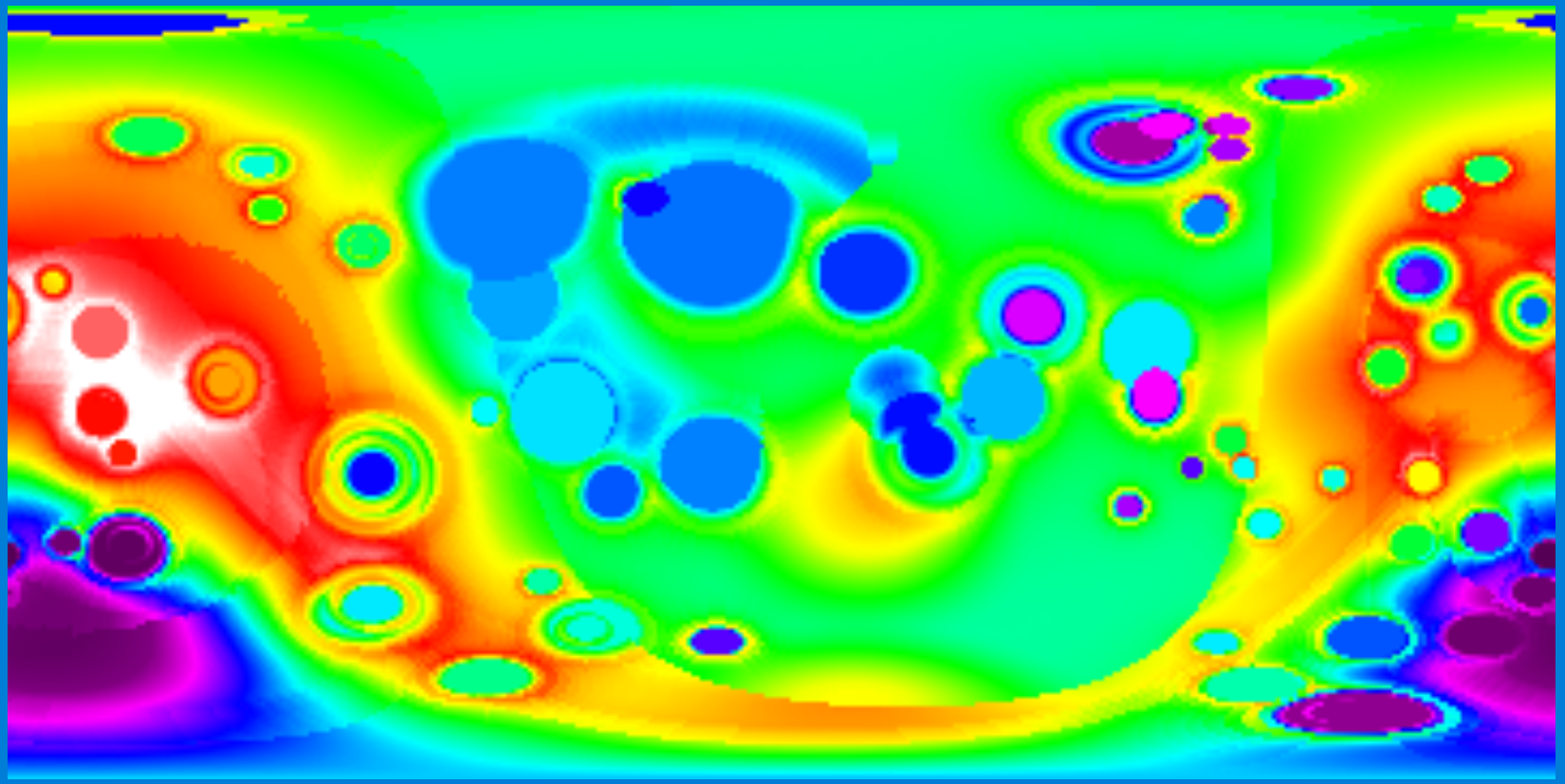
Lower Imbrian (100 Ma)



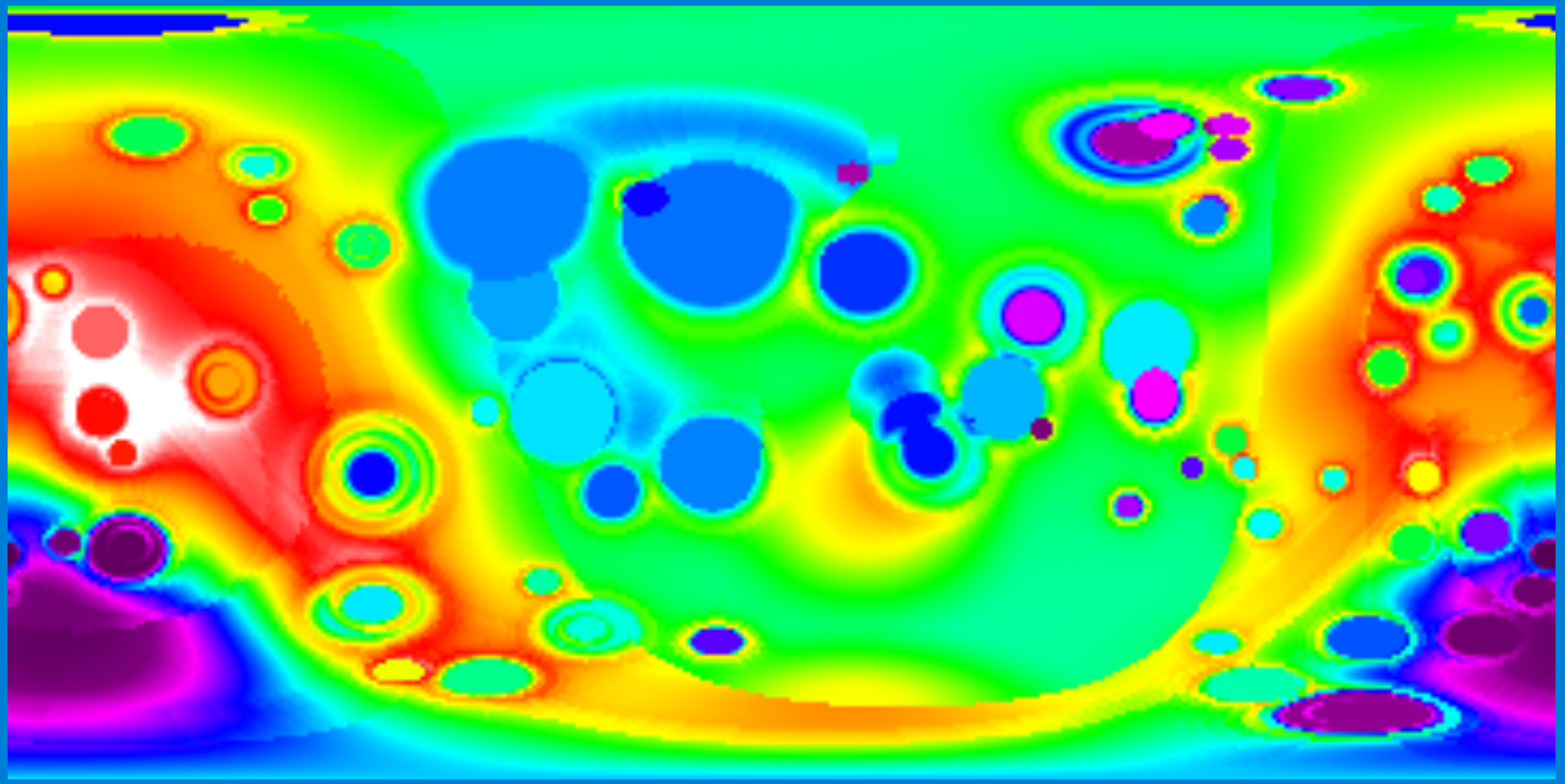
Upper Imbrian (400 Ma)



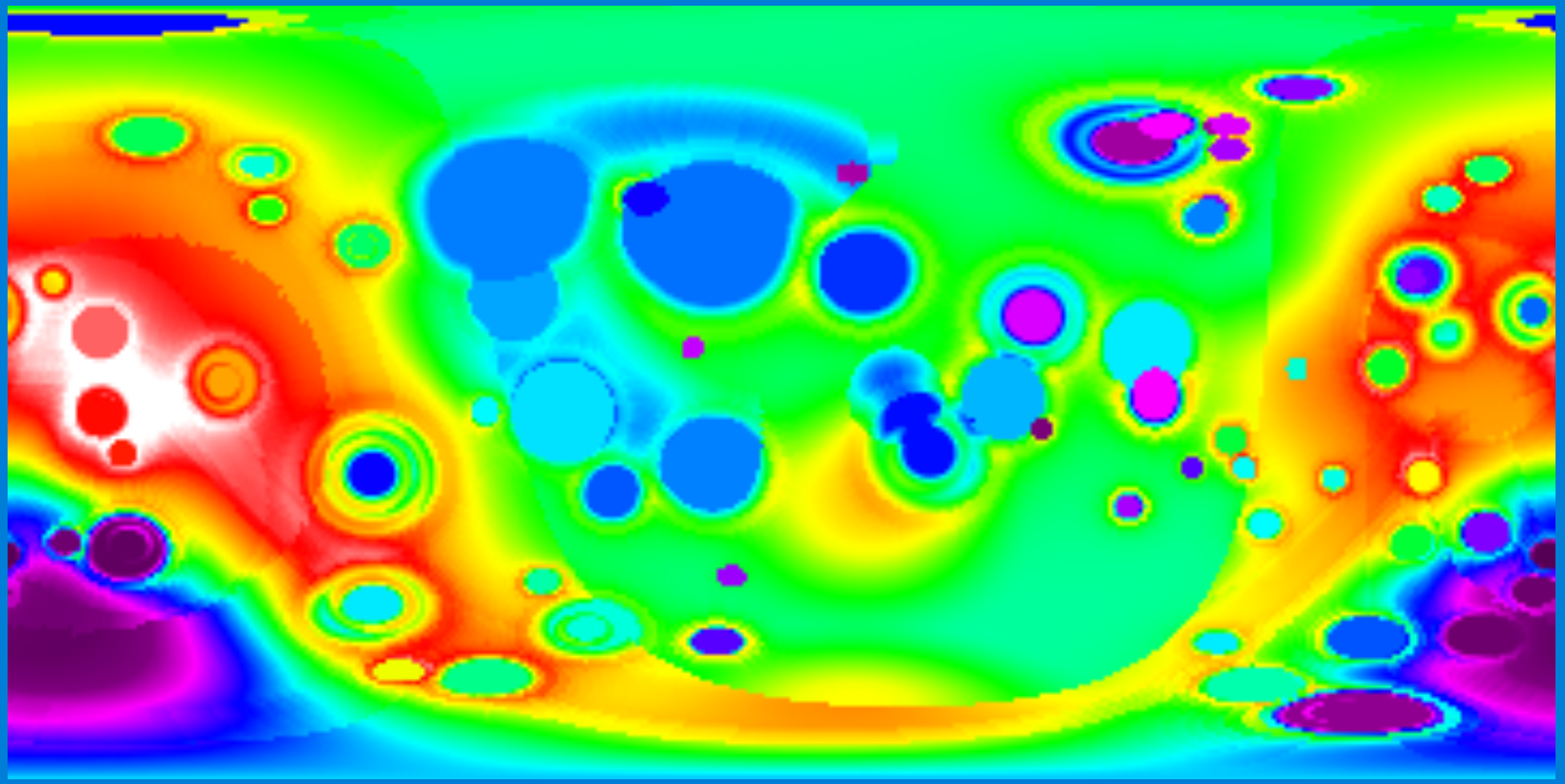
Upper Imbrian + Maria



Eratosthenian (2400 Ma)



Copernican (800 Ma to present)



Summary

- Major features of the Moon's surface have been deconstructed from topography
- Three megabasins established the general topography and crustal thickness
- Intensive bombardment followed and volcanic lava erupted through thinned crust
- Mineral anomalies are associated with the melt columns of the NSM and SPA

Questions?